TF 2404

TF 2404

INCORPORATING THE /2M1 MODIFICATION

Out of Limits Indicator

OPERATING INSTRUCTIONS

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

OUT OF LIMITS INDICATOR
TYPE TF 2404

AMENDMENT RECORD

A/L No.	Date of issue	Amended by	Date
1	Feb 68	GLt	1-3-68

OPERATING INSTRUCTIONS

No. EB 2404

for

Out of Limits Indicator

TF 2404

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1965

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

C.P. 1c
8/66/B

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I GENERAL INFORMATION

1.1 INTRODUCTION

The TF 2404 monitors readings from a counter and compares them with two preset limits; it indicates whether a reading is above the High limit, below the Low limit, or between the two. The indication takes the form of a visual signal, and either a relay contact closure or an electrical pulse. Limits are usually set up on front panel switches, but remote operation can be arranged as an optional facility.

Two modes of operation are available; either the indication is held until the next count is complete, when it automatically sets to the next indication, or alternatively, when an out-of-limits indication occurs it remains until the manual reset has been operated whether or not further readings have been taken.

Although the TF 2404 has been specifically designed for use with Marconi Instruments counters TF 1417 series and TF 2401, it can be used with any digital equipment which meets its input requirements.

Bench or rack-mounting versions of the instrument are available.

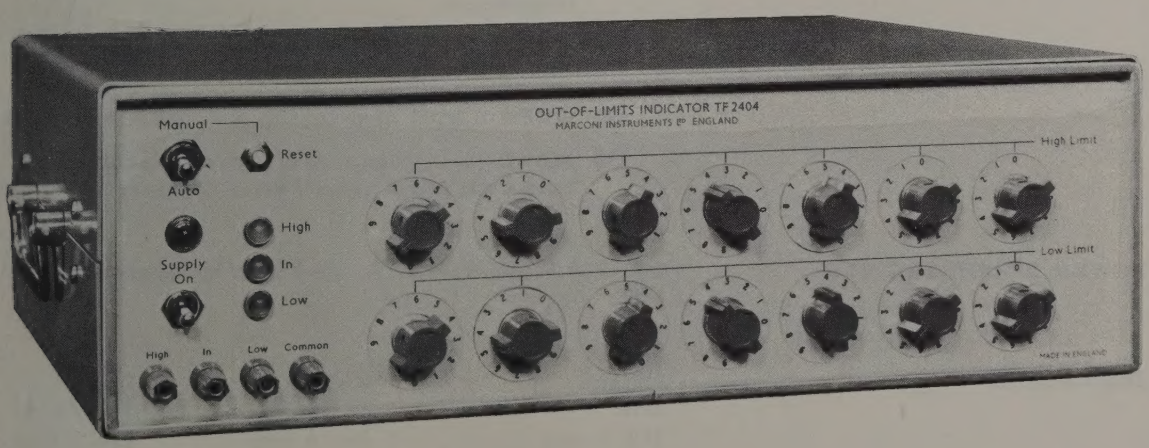


Fig. 1.1 Out of Limits Indicator TF 2404

1.2 DATA SUMMARY

INPUT CAPACITY :	7 digits.
INPUT DRIVE REQUIREMENTS :	Parallel entry, 4 line, 1-2-4-8 BCD. '0' state; -0.2 V to +10 V. '1' state; -1.25 V to -50 V. Input resistor; 4.7 kΩ nominal.
SET-UP COMMAND :	1) Negative pulse; Duration; 5 μsec minimum. 2.5 Voltage swing; 0 to ~~-1.25~~ V minimum, 4.2 0 to ~~-40~~ 10 V maximum. Rise time; 1 μsec (maximum). Input resistor; 10 kΩ nominal. 2) By front panel push switch.
LIMITS RANGE :	HIGH and LOW; 0 to 9,999,999.
INDICATION :	HIGH, IN, and LOW. 1) Visual, by front panel lamps. 2) Electrical (a) by relay contact closures; contact rating, 100 V d.c., 1A, 30 W. (b) by simple internal wiring rearrangements; relays may be unplugged and indication given by voltage level on appropriate one of three terminals. (See Section 2.4 for details.) Output; +10 V nominal at 330 Ω minimum impedance.
INDICATION DURATION :	Switch selects (a) AUTO : until next set-up command is received. (b) MANUAL : when out-of-limits is indicated, held until front panel switch is operated.
POWER REQUIREMENTS :	190-260 V and 95-130 V, 45-500 c/s; approximately 6 W.

DIMENSIONS	Height	Width	Depth
	6 in (15.2 cm)	18 1/4 in (46.4 cm)	14 1/4 in (36.2 cm)

WEIGHT :	18½ lb (8.4 kg).

ACCESSORIES SUPPLIED : Board Extractor, type TM 8089.

ACCESSORIES AVAILABLE :

Interconnecting cable, type TM 4726/269, to mate with Counter type TF 1417 (series).

Interconnecting cable, type TM 4726/271, to mate with Counter type TF 2401.

Extender Board, type TM 7878. Holds printed circuit boards clear of instrument during servicing.

40-way socket, to mate with input connector on rear panel.

2 OPERATION

2.1 INSTALLATION

The mains lead is a free cable fitted at one end with a female plug which connects with the instrument. When fitting a mains plug, note that the earth (or chassis) conductor has a yellow designation sleeve with a green circuit earth symbol, the neutral conductor has a black sleeve with a white 'N', and the line (or phase) conductor has no sleeve. The rack-mounting version is not supplied with a mains lead.

Check that the transformer tapping and fuse rating are correct for the voltage available before connecting the instrument to the power supply (see Section 4.2).

2.2 CONTROLS AND CONNECTORS

(1) HIGH LIMIT switches. Set up seven digit high limit; least significant digit on extreme right.

(2) LOW LIMIT switches. Set up seven digit low limit; least significant digit on extreme right.

(3) Mode switch. Set to AUTO for automatic indication of sequential out-of-limits counter readings. Set to MANUAL to hold out-of-limits indication until RESET button is operated.

(4) RESET button.

(5) Output terminal; HIGH. Signal indicating that reading is above higher limit is delivered at this terminal.

(6) Output terminal; IN. Signal indicating that reading is between limits is delivered at this terminal.

(7) Output terminal; LOW. Signal indicating that reading is below lower limit is delivered at this terminal.

(8) Input terminal; COMMON. Voltage applied to this terminal determines output level from (5), (6) and (7).

(9) Indicator lamp; LOW. On for low out-of-limits readings.

(10) Indicator lamp; IN. On for reading between limits.

(11) Indicator lamp; HIGH. On for high out-of-limits reading.

(12) SUPPLY switch.

(13) Pilot lamp.

The following are located on the rear panel.

INPUT connector. Connect to counter or other digital equipment.

HIGH; IN; LOW; COMMON terminals. Alternatives to those on front panel.

FUSES (2) Supply. 230 V-0.5 A; 115 V-1 A.

FUSES (2) D.C. 1A, for internally generated supplies.

MAINS INPUT socket.

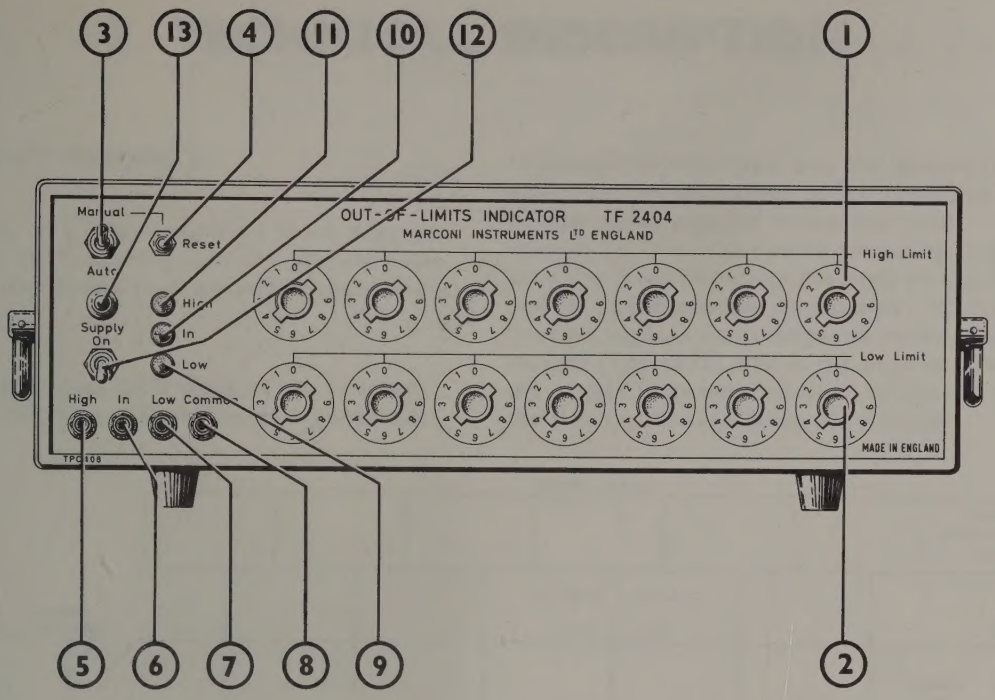


Fig. 2.1 Controls and connectors

2.3 OPERATING PROCEDURE

Connect the output from the counter to the INPUT connector on the rear panel.

Set up limits on front panel switches.

Select operating mode; MANUAL or AUTO. If MANUAL is selected, an out-of-limits indication will be held, regardless of further readings, until the RESET button is operated.

If external equipment is to be driven, connect an appropriate voltage to the COMMON terminal; a high, in or low indication will be delivered at the other terminals, at this voltage, via relays.

2.4 OBTAINING PULSE OUTPUT

The output from the drive transistors can be delivered to the output terminals by rearranging the internal wiring as follows :-

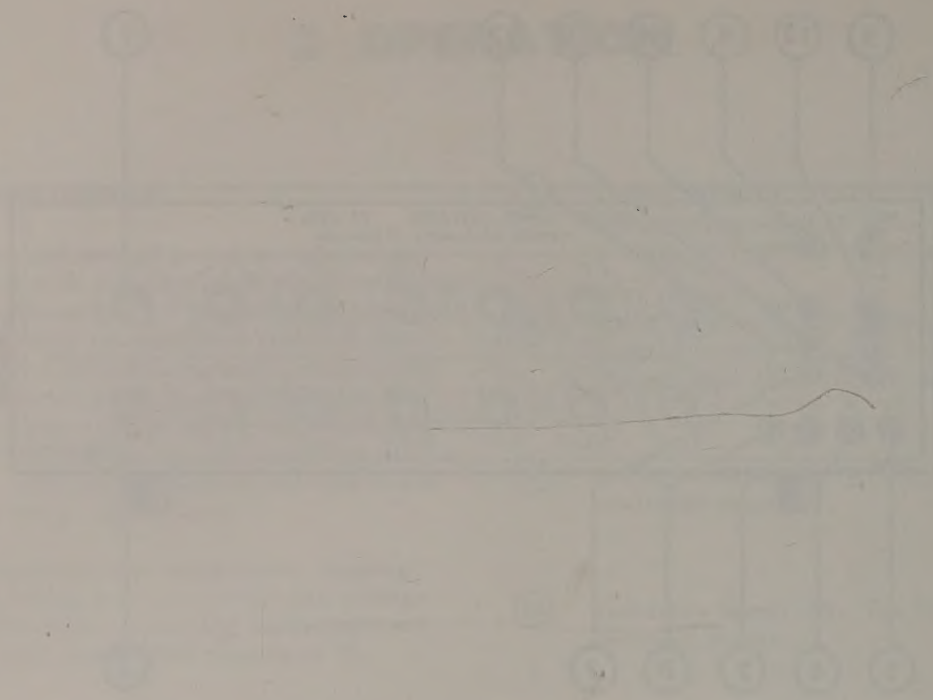
1) Remove the top and bottom covers.

2) Unplug the relays.

3) Connect the COMMON terminal to chassis.

4) Connect a 330 Ω resistor between pins 4 and 10 on each relay base.

This procedure will make available an output of +10 V at a 330 Ω impedance.



3 TECHNICAL DESCRIPTION

3.1 CIRCUIT SUMMARY

Fig. 3.1 is a simplified block diagram of the TF 2404 showing how the plug-in units are interconnected to achieve the instrument's function.

Each 4-line BCD digit of the counter reading, starting with the least significant, is compared with high and low preset limits; a borrow is generated, of the result of each comparison, and fed to the next unit. This borrow is '1' if the counter reading is greater than the limit (whether the high or the low) and '0' if the reading is smaller. The final borrow signals are compared in the output circuit (TM 7872) where the appropriate output signal is generated when triggered by the print command from the counter.

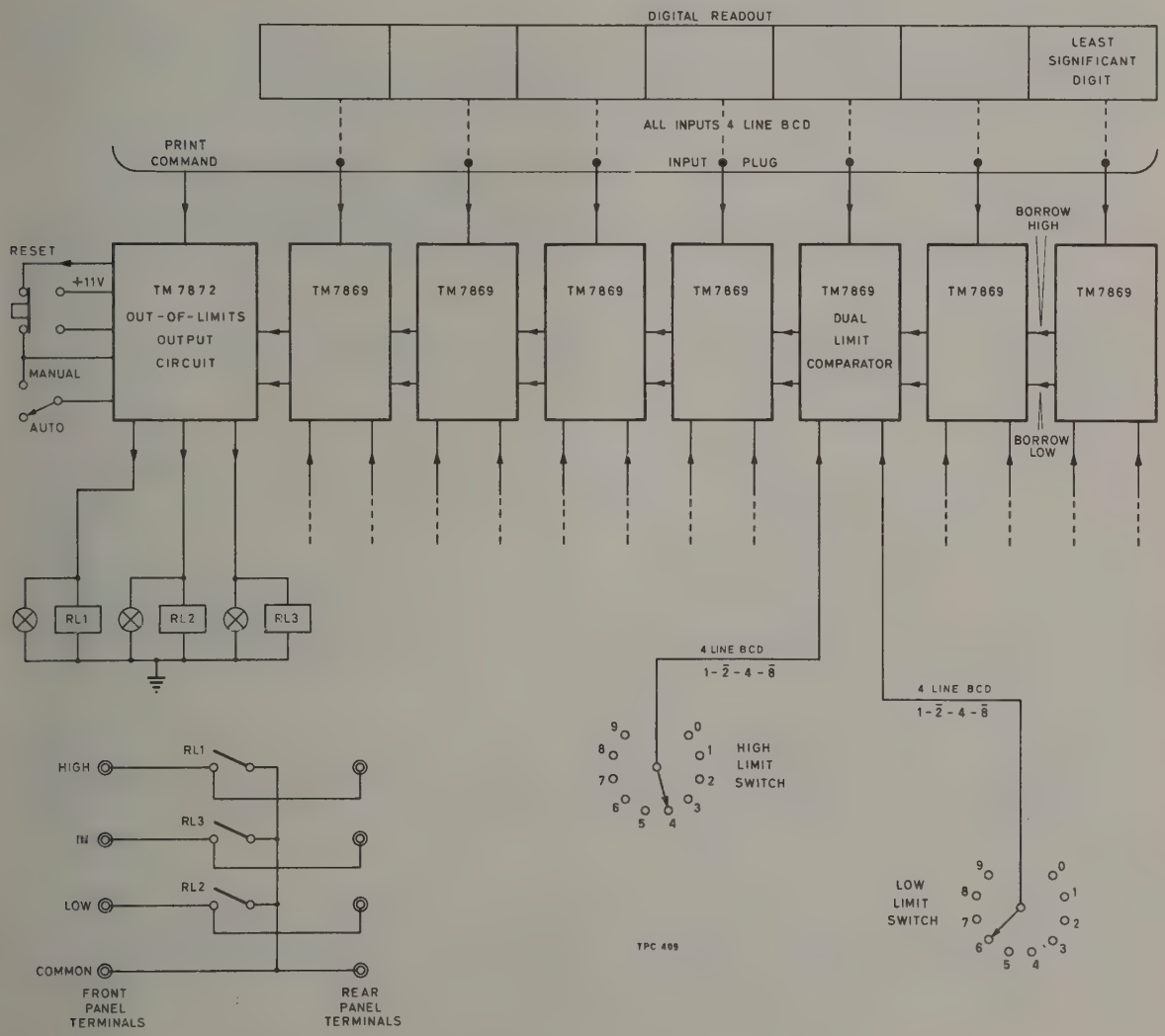


Fig. 3.1 Block diagram

3.2 LOGIC DEFINITIONS

Logic diagrams are used in the handbook to help give an understanding of the operation of the circuit or board, and show how the elements are functionally interconnected.

Below (Fig. 3.2) are the definitions of the logic symbols which are used in the description of the various circuits.

In general, the '1' state is -11 V and the '0' state is 0 V. Also, note that '$\overline{x}$' means 'not x', i.e., the inverse of 'x'.

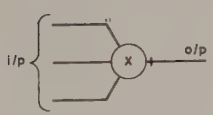
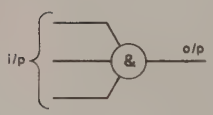
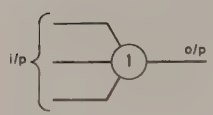
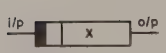
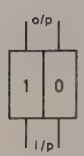
Symbol	Title	Description
	amplifier	
	inverter	changes phase of input signal.
	threshold gate with negated output	the figure inside the symbol (x) indicates the minimum number of input signals which must be in the '1' state (i.e., active) before the output is in the '0' state.
	AND gate	all inputs must be in the '1' state for the output to be in the '1' state.
	OR gate	one or more inputs in the '1' state will give a '1' state output.
	inhibit gate	a '1' state signal on the inhibit input prevents the output from being in the '1' state no matter what condition of the other input (or inputs).
	pulse generator	start of input triggers output of predetermined duration (x).
	bistable circuit	a momentary signal on one input will set the corresponding output to the '1' state, where it will remain until a signal is applied to the other input.

Fig. 3.2 Logic symbols

3.3 DUAL LIMIT COMPARATOR: TM 7869

The dual limit comparator compares a BCD digit from the counter with two limits, and generates the borrow signals for the next comparator unit. Fig. 4.2 shows the circuit diagram for this board.

Fig. 3.3 shows the logic diagram for one unit. All the gates in the unit are negated output threshold gates, which require at least two of the three inputs to be at -11 V before the transistor will conduct to give a 0 V output.

The borrow into one comparator unit depends only on the units of lesser significance; what this borrow will be, is shown in Table 1. It must be remembered that if the borrow (B) is '1', then $\overline{B}$ will be '0'.

TABLE 1

Borrow (from one unit to the next)	Reading		
	> preset	= preset	< preset
$\overline{B}_H$	0 V	-11 V	-11 V
$\overline{B}_L$	0 V	0 V	-11 V

An artificial borrow is generated for the least significant digit, this borrow being arranged so that the input to the high preset side ($\overline{B}_H$) is -11 V, and the input to the low preset side ($\overline{B}_L$) is 0 V. These values are chosen so that in the case where the limit and reading are the same, an 'in-limits' indication is given.

3.4 OUT OF LIMITS OUTPUT CIRCUIT: TM 7872

This unit accepts the borrow signals from the most significant digit comparator, and produces a 'high', 'low', or 'in' signal dependent on the states of the borrow signals. Fig. 3.4 shows the logic diagram for the unit, and Fig. 4.3 the circuit diagram. The states of the borrow inputs for each output indication, is shown in Table 2; as the $\overline{B}$

TABLE 2

Active o/p	State of borrow i/p	
	$\overline{B}_L$	$\overline{B}_H$
HIGH	0 (0 V)	0 (0 V)
LOW	1 (-11 V)	1 (-11 V)
IN	0 (0 V)	1 (-11 V)

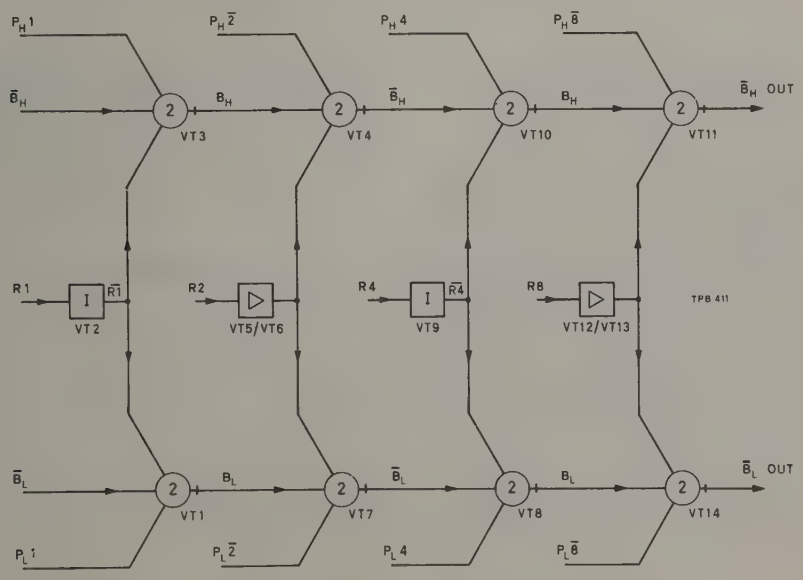


Fig. 3.3 Dual limit comparator: Logic diagram

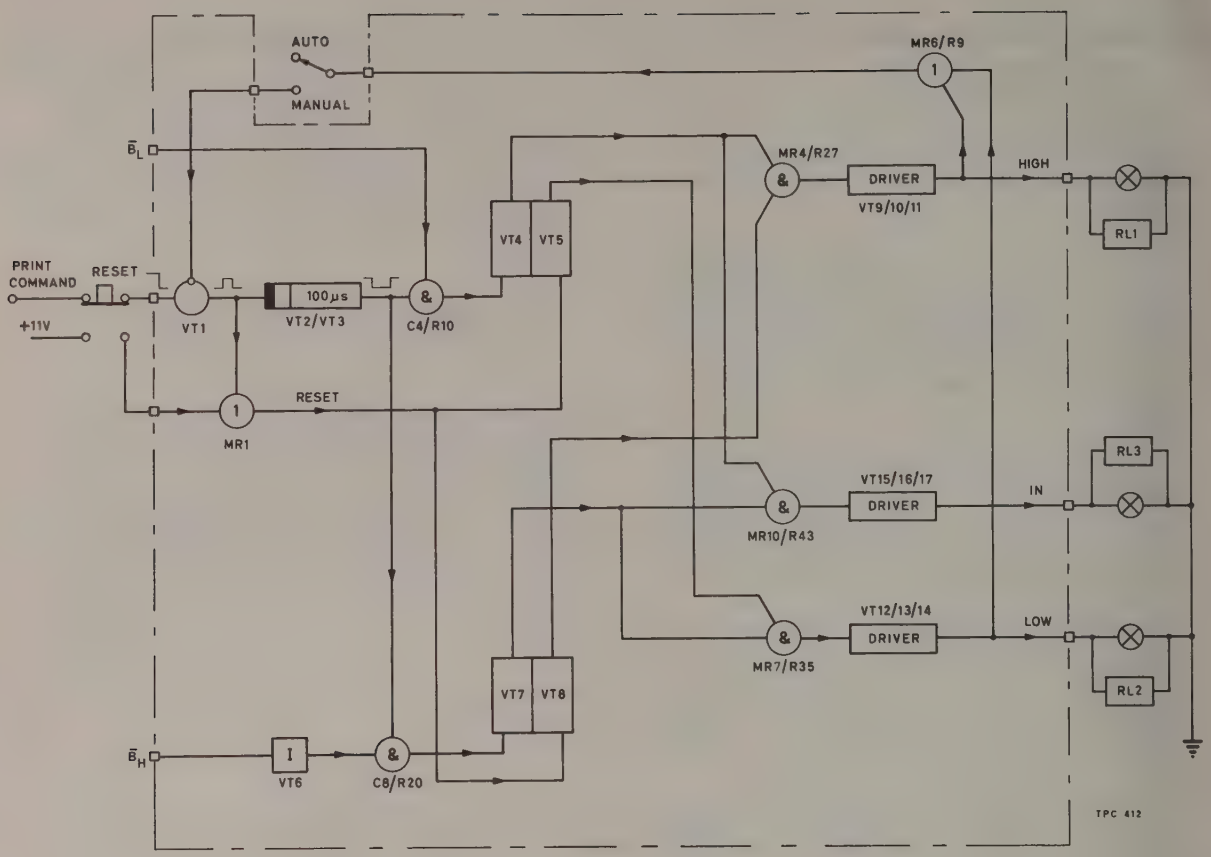


Fig. 3.4 Out of limits output circuit: Logic diagram

signal is used the '0' state of the input denotes that a borrow has been generated.

Referring to Fig. 3.4, with the switch in the AUTO position, the positive edge of the inverted print command input will reset the bistables and trigger the pulse generator. The positive edge of the pulse generated will set up the bistables to the required state (dependent upon $\overline{B}_H$ and $\overline{B}_L$) 100 µsec after they have been reset. The outputs from the bistables are gated in simple diode/resistor AND gates to form the drives for the relay/lamp drivers.

When the switch is set to MANUAL, an output from either the High or Low driver will inhibit the input gate so preventing further inputs from having any effect on the system. This inhibit will remain until the RESET button is operated to reset the bistables and thus clear the inhibiting signal.

3.5 POWER SUPPLY: TM 7865

Only two supply rails, +11 V and -11 V, are used. Conventional series regulator circuits are used in the production of these supplies, and the -11 V rail forms the reference supply for +11 V rail. The circuit diagram for the power supply is shown in Fig. 4.4.

4 MAINTENANCE NOTES

4.1 GENERAL

This section is intended as a general guide to the servicing of the instrument. In case of difficulties, please contact our Service Division at the address on the back cover or your nearest Marconi Instruments representative.

Semiconductor devices are used throughout the instrument and although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reversed polarity, and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation, short circuits, or use of insulation testers.

4.2 TRANSFORMER CONNECTIONS

The transformer connections need be changed only when the instrument supply voltage is changed from the 190-260 V range to the 95-130 V range, or vice versa.

A diagram showing the two connections is located between the two transformer tag strips which are made available by removing the instrument bottom cover.

4.3 ACCESS TO PLUG-IN BOARDS

Remove the top cover of the instrument by withdrawing the two screws above the handles, on each side. When the cover is off, remove the retaining bar across the top of the boards by slackening the captive screw in the centre of each end. Boards can now be removed with the aid of the board extractor which is normally housed in the retaining bar.

CAUTION To avoid damaging transistors, do not remove or replace any of the plug-in units while the instrument is switched on.

When replacing boards, care must be taken to fit them into their correct sockets; Fig. 4.1 shows the board distribution in the instrument.

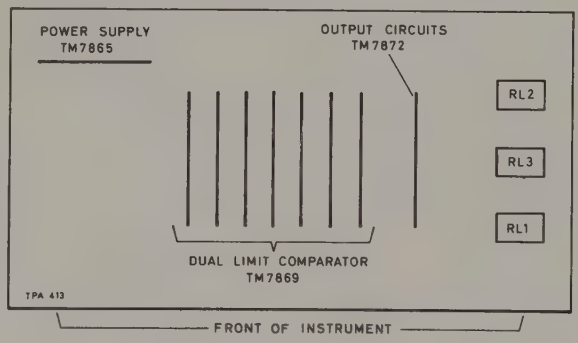


Fig. 4.1 Board distribution

4.4 PRESET COMPONENTS

The two variable resistors on the power supply board are the only preset or selected components in the instrument. They can be adjusted through the two holes in the instrument rear panel; RV1, controlling the -11 V line, must be set up before RV2, which controls the +11 V line.

No special setting-up procedure is required; simply monitor with a voltmeter at a convenient point on the supply rails, and adjust the resistors for -11 V and +11 V on the meter.

LIST OF REPLACEABLE PARTS

Introduction

This section lists replaceable parts in alphabetical order of their circuit reference, with miscellaneous parts at the end of the list. A separate parts list is given for each circuit diagram. The following abbreviations are used:

Carb	:	carbon
DPDT	:	double pole, double throw

Note: Throughout the lists, resistor wattages are referred to 70°C unless otherwise stated.

Ordering

When ordering replacement parts, address the order to our Service Division. Specify the following information for each part required:

1) Type and serial number of instrument.

2) Circuit reference.

3) Description.

4) M.I. code number.

If a part is not listed, state its function, location and description when ordering.

Interconnecting diagram

Circuit reference	*Description*	*M.I. code*
Fuses		
FS1	Mains 0.5A	23411-056
FS2	Mains 0.5A	23411-056
FS3	D.C. 1A	23411-058
FS4	D.C. 1A	23411-058
Indicating lamps		
ILP1	HIGH	23735-459
ILP2	LOW	23735-459
ILP3	IN	23735-459
Plugs		
PLA	Mains input	23423-151
PLB	INPUT CONNECTOR	23435-419
Pilot lamp		
PLP1	SUPPLY 100-125V Red	23733-112
Relays		
RL A	HIGH Type 25 10-19V	23486-133
RL B	LOW Type 25 10-19V	23486-133
RL C	IN Type 25 10-19V	23486-133
Switches		
SA	SUPPLY DPDT	44334-003
SB	RESET Push button	23465-204
SC	Mode DPDT	44334-003
SD	LIMIT switch 12 position	44326-415
SE	LIMIT switch 12 position	44326-415
SF	LIMIT switch 12 position	44326-415
SG	LIMIT switch 12 position	44326-415
SH	LIMIT switch 12 position	44326-415
SJ	LIMIT switch 12 position	44326-415
SK	LIMIT switch 12 position	44326-415
SL	LIMIT switch 12 position	44326-415
SM	LIMIT switch 12 position	44326-415
SN	LIMIT switch 12 position	44326-415
SP	LIMIT switch 12 position	44326-415
SQ	LIMIT switch 12 position	44326-415
SR	LIMIT switch 12 position	44326-415
SS	LIMIT switch 12 position	44326-415
Terminals		
	HIGH	23235-176
	LOW	23235-176
	IN	23235-176
	COMMON	23235-176
	Mains Lead	43122-017
Knobs		
	LIMIT switches	41145-201

Power Supply: TM 7865

Circuit reference	Description	M.I. code
Capacitors		
C1	Elec 2500µF +50% -20% 25V	26427-132
C2	Elec 2500µF +50% -20% 25V	26427-132
C3	Cer 0.01µF +80% -20% 100V	26383-055
C4	Cer 0.01µF +80% -20% 100V	26383-055
C5	Elec 100µF +100% -20% 25V	26417-158
C6	Elec 100µF +100% -20% 25V	26417-158
Diodes		
MR1	IN 540	28357-044
MR2	IN 540	28357-044
MR3	IN 540	28357-044
MR4	IN 540	28357-044
MR5	IN 540	28357-044
MR6	6.8V Zener	28371-546
Variable resistors		
RV1	Carb 1kΩ ±20% ¼W	25611-114
RV2	Carb 2.2kΩ ±20% ¼W	25611-118

Circuit reference	Description	M.I. code
Resistors		
R1	Carb 39Ω ±10% ¼W	24342-035
R2	Carb 1.5kΩ ±10% ¼W	24342-084
R3	Carb 10kΩ ±10% ¼W	24342-110
R4	Carb 220Ω ±10% ¼W	24342-058
R5	Carb 470Ω ±10% ¼W	24342-069
R6	Carb 680Ω ±10% ¼W	24342-076
R7	Carb 470Ω ±10% ¼W	24342-069
R8	Carb 1.2kΩ ±10% ¼W	24342-082
R9	Carb 820Ω ±10% ¼W	24342-078
R10	Carb 10kΩ ±10% ¼W	24342-110
R11	Carb 2.2kΩ ±5% ¼W	24332-088
R12	Carb 4.7kΩ ±5% ¼W	24332-100
R13	Carb 4.7kΩ ±5% ¼W	24332-100
Transformer		
T1	TM 7586/1	43461-016
Transistors		
VT1	ACY20	28424-747
VT2	2N1553	28424-886
VT3	ACY20	28424-747
VT4	BFY17	28453-543
VT5	2N1553	28424-886
VT6	ACY20	28424-747

Dual Limit Comparator: TM 7869

Circuit reference		Description	M.I. code
Resistors			
R1	Carb	47kΩ ±5% ¼W	24332-126
R2	Carb	47kΩ ±5% ¼W	24332-126
R3	Carb	47kΩ ±5% ¼W	24332-126
R4	Carb	39kΩ ±5% ¼W	24332-124
R5	Carb	4.7kΩ ±5% ¼W	24332-100
R6	Carb	4.7kΩ ±5% ¼W	24332-100
R7	Carb	180kΩ ±10% ¼W	24342-141
R8	Carb	2.2kΩ ±5% ¼W	24332-088
R9	Carb	47kΩ ±5% ¼W	24332-126
R10	Carb	47kΩ ±5% ¼W	24332-126
R11	Carb	47kΩ ±5% ¼W	24332-126
R12	Carb	39kΩ ±5% ¼W	24332-124
R13	Carb	4.7kΩ ±5% ¼W	24332-100
R14	Carb	47kΩ ±5% ¼W	24332-126
R15	Carb	47kΩ ±5% ¼W	24332-126
R16	Carb	47kΩ ±5% ¼W	24332-126
R17	Carb	39kΩ ±5% ¼W	24332-124
R18	Carb	4.7kΩ ±5% ¼W	24332-100
R19	Carb	4.7kΩ ±5% ¼W	24332-100
R20	Carb	180kΩ ±10% ¼W	24342-141
R21	Carb	2.2kΩ ±5% ¼W	24332-088
R22	Carb	33kΩ ±5% ¼W	24332-122
R23	Carb	180kΩ ±10% ¼W	24342-141
R24	Carb	2.2kΩ ±5% ¼W	24332-088
R25	Carb	47kΩ ±5% ¼W	24332-126
R26	Carb	47kΩ ±5% ¼W	24332-126
R27	Carb	47kΩ ±5% ¼W	24332-126
R28	Carb	39kΩ ±5% ¼W	24332-124
R29	Carb	4.7kΩ ±5% ¼W	24332-100
R30	Carb	47kΩ ±5% ¼W	24332-126
R31	Carb	47kΩ ±5% ¼W	24332-126
R32	Carb	47kΩ ±5% ¼W	24332-126
R33	Carb	39kΩ ±5% ¼W	24332-124
R34	Carb	4.7kΩ ±5% ¼W	24332-100
R35	Carb	4.7kΩ ±5% ¼W	24332-100
R36	Carb	180kΩ ±10% ¼W	24342-141
R37	Carb	2.2kΩ ±5% ¼W	24332-088
R38	Carb	47kΩ ±5% ¼W	24332-126
R39	Carb	47kΩ ±5% ¼W	24332-126
R40	Carb	47kΩ ±5% ¼W	24332-126
R41	Carb	39kΩ ±5% ¼W	24332-124
R42	Carb	4.7kΩ ±5% ¼W	24332-100
R43	Carb	47kΩ ±5% ¼W	24332-126
R44	Carb	47kΩ ±5% ¼W	24332-126
R45	Carb	47kΩ ±5% ¼W	24332-126
R46	Carb	39kΩ ±5% ¼W	24332-124
R47	Carb	4.7kΩ ±5% ¼W	24332-100
R48	Carb	4.7kΩ ±5% ¼W	24332-100
R49	Carb	180kΩ ±10% ¼W	24342-141
R50	Carb	2.2kΩ ±5% ¼W	24332-088
R51	Carb	33kΩ ±5% ¼W	24332-122
R52	Carb	180kΩ ±10% ¼W	24342-141
R53	Carb	2.2kΩ ±5% ¼W	24332-088
R54	Carb	47kΩ ±5% ¼W	24332-126
R55	Carb	47kΩ ±5% ¼W	24332-126
R56	Carb	47kΩ ±5% ¼W	24332-126
R57	Carb	39kΩ ±5% ¼W	24332-124
R58	Carb	4.7kΩ ±5% ¼W	24332-100
Transistors			
VT1	2N404		28423-508
VT2	2N404		28423-508
VT3	2N404		28423-508
VT4	2N404		28423-508
VT5	2N404		28423-508
VT6	2N404		28423-508
VT7	2N404		28423-508
VT8	2N404		28423-508
VT9	2N404		28423-508
VT10	2N404		28423-508
VT11	2N404		28423-508
VT12	2N404		28423-508
VT13	2N404		28423-508
VT14	2N404		28423-508

Out of Limits Output Circuit: TM 7872

Circuit reference		Description	M.I. code
Capacitors			
C1	Paper	220pF ±20% 600V	26174-118
C2	Paper	.001μF ±10% 500V	26174-125
C3	Paper	220pF ±20% 600V	26174-118
C4	Paper	220pF ±20% 600V	26174-118
C5	Paper	220pF ±20% 600V	26174-118
C6	Paper	220pF ±20% 600V	26174-118
C7	Paper	220pF ±20% 600V	26174-118
C8	Paper	220pF ±20% 600V	26174-118
C9	Paper	220pF ±20% 600V	26174-118
C10	Paper	220pF ±20% 600V	26174-118
C11	Paper	220pF ±20% 600V	26174-118
Diodes			
MR1	HG1005		28323-035
MR2	HG1005		28323-035
MR3	HG1005		28323-035
MR4	HG1005		28323-035
MR4	HG1005		28323-035
MR5	OA202		28337-534
MR6	HG1005		28323-035
MR7	HG1005		28323-035
MR8	OA202		28337-534
MR9	HG1005		28323-035
MR10	HG1005		28323-035
MR11	OA202		28337-534
MR12	1S44		28337-538
Resistors			
R1	Carb	~~4.7kΩ~~ 10 ±10% ½W	24343-~~100~~ 110
~~R2~~	~~Carb~~	~~4.7kΩ ±10% ½W~~	~~24343-100~~
R3	Carb	150kΩ ±10% ¼W	24342-139
R4	Carb	6.8kΩ ±10% ¼W	24342-106
R5	Carb	120kΩ ±10% ¼W	24342-137
R6	Carb	3.3kΩ ±5% ¼W	24332-094
R7	Carb	33kΩ ±5% ¼W	24332-122
R8	Carb	3.3kΩ ±5% ¼W	24332-094
R9	Carb	150kΩ ±10% ¼W	24342-139
R10	Carb	47kΩ ±5% ¼W	24332-126
R11	Carb	180kΩ ±10% ¼W	24342-141
R12	Carb	2.2kΩ ±5% ¼W	24332-088
R13	Carb	33kΩ ±5% ¼W	24332-122
R14	Carb	33kΩ ±5% ¼W	24332-122
R15	Carb	180kΩ ±10% ¼W	24342-141
R16	Carb	2.2kΩ ±5% ¼W	24332-088
R17	Carb	33kΩ ±5% ¼W	24332-122
R18	Carb	180kΩ ±10% ¼W	24342-141
R19	Carb	2.2kΩ ±5% ¼W	24332-088
R20	Carb	47kΩ ±5% ¼W	24332-126
R21	Carb	180kΩ ±10% ¼W	24342-141
R22	Carb	2.2kΩ ±5% ¼W	24332-088
R23	Carb	33kΩ ±5% ¼W	24332-122
R24	Carb	33kΩ ±5% ¼W	24332-122
R25	Carb	180kΩ ±10% ¼W	24342-141
R26	Carb	2.2kΩ ±5% ¼W	24332-088
R27	Carb	33kΩ ±5% ¼W	24332-122
R28	Carb	12kΩ ±5% ¼W	24332-112
R29	Carb	180kΩ ±10% ¼W	24342-141
R30	Carb	4.7kΩ ±5% ¼W	24332-100
R31	Carb	2.2kΩ ±5% ¼W	24332-088
R32	Carb	2.7kΩ ±10% ¼W	24342-092
R33	Carb	15kΩ ±10% ¼W	24342-114
R34	Carb	27kΩ ±10% ¼W	24342-120
R35	Carb	33kΩ ±5% ¼W	24332-122
R36	Carb	12kΩ ±5% ¼W	24332-112
R37	Carb	180kΩ ±10% ¼W	24342-141
R38	Carb	4.7kΩ ±5% ¼W	24332-100
R39	Carb	2.2kΩ ±5% ¼W	24332-088
R40	Carb	2.7kΩ ±10% ¼W	24342-092
R41	Carb	15kΩ ±10% ¼W	24342-114
R42	Carb	27kΩ ±10% ¼W	24342-120
R43	Carb	33kΩ ±5% ¼W	24332-122
R44	Carb	12kΩ ±5% ¼W	24332-112
R45	Carb	180kΩ ±10% ¼W	24342-141
R46	Carb	4.7kΩ ±5% ¼W	24332-100

Circuit reference	Description	M.I. code
R47	Carb 2.2kΩ ±5% ¼W	24332-088
R48	Carb 2.7kΩ ±10% ¼W	24342-092
R49	Carb 15kΩ ±10% ¼W	24342-114
R50	Carb 27kΩ ±10% ¼W	24342-120

Transistors

VT1	2N404	28423-508
VT2	2N404	28423-508
VT3	2N404	28423-508
VT4	2N404	28423-508
VT5	2N404	28423-508
VT6	2N404	28423-508
VT7	2N404	28423-508
VT8	2N404	28423-508
VT9	2N404	28423-508
VT10	2N404	28423-508
VT11	2N1304	28443-528
VT12	2N404	28423-508
VT13	2N404	28423-508
VT14	2N1304	28443-528
VT15	2N404	28423-508
VT16	2N404	28423-508
VT17	2N1304	28443-528

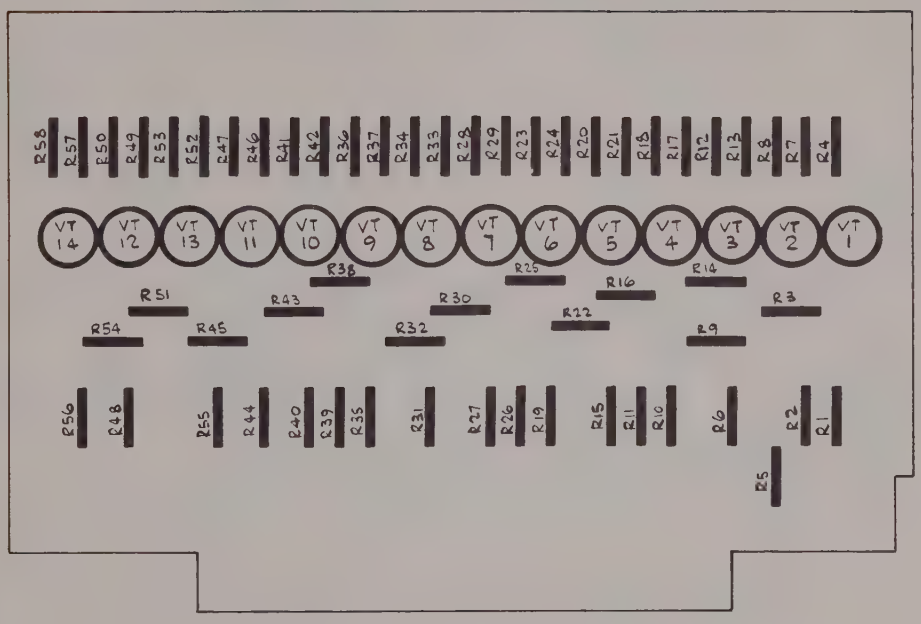
CIRCUIT NOTES

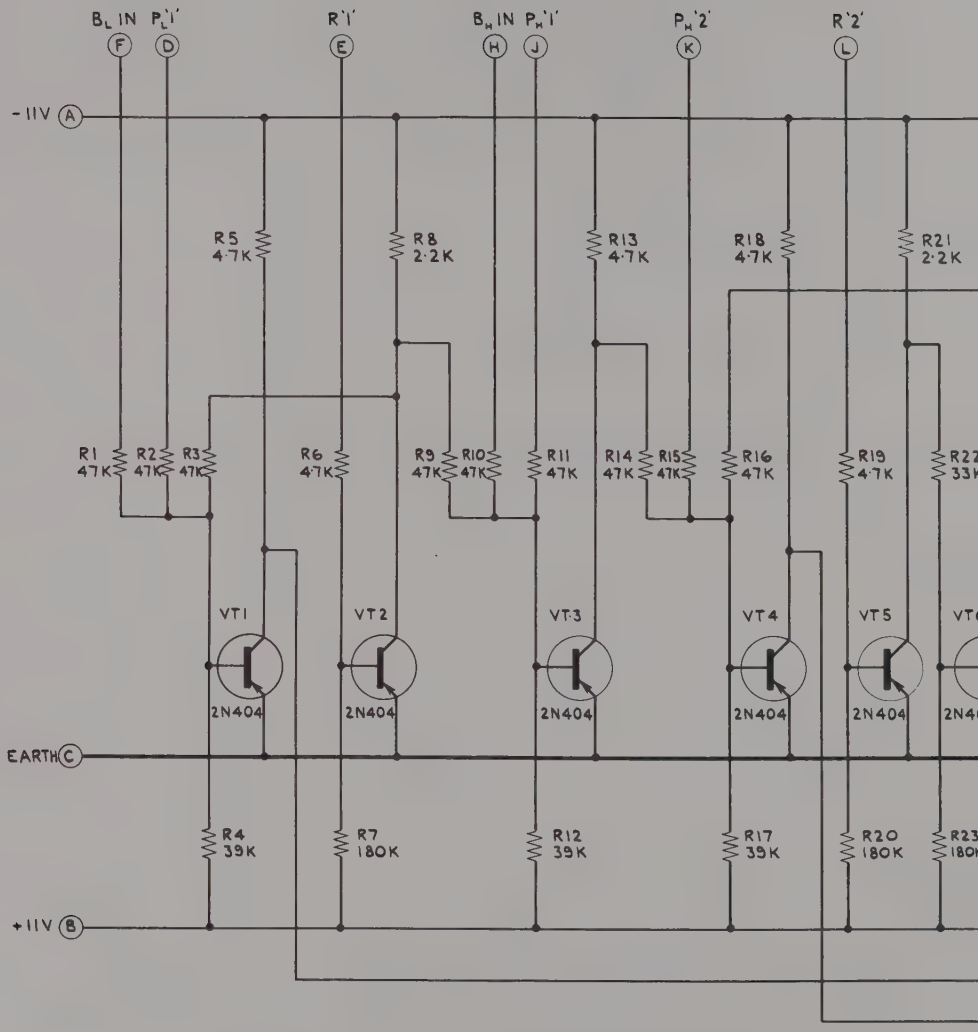
1. COMPONENT VALUES

Resistors : No suffix = ohms. k = kilohms. M = megohms.
Capacitors : No suffix = microfarads. p = picofarads.
* value selected during test; nominal value shown.

2. SYMBOLS

arrow indicates clockwise rotation of knob.


R58
R57
R50
R49
R53
R52
R47
R46
R41
R42
R36
R37
R34
R33
R28
R29
R23
R24
R20
R21
R18
R17
R12
R13
R8
R7
R4
VT 14
VT 12
VT 13
VT 11
VT 10
VT 9
VT 8
VT 7
VT 6
VT 5
VT 4
VT 3
VT 2
VT 1
R38
R25
R16
R14
R51
R43
R30
R3
R54
R45
R22
R32
R9
R56
R48
R55
R44
R40
R39
R35
R31
R27
R26
R19
R15
R11
R10
R6
R2
R1
R5



P_L LOW PRESET.
P_H HIGH PRESET.
B BORROW SIGNAL.
R COUNTER READING.

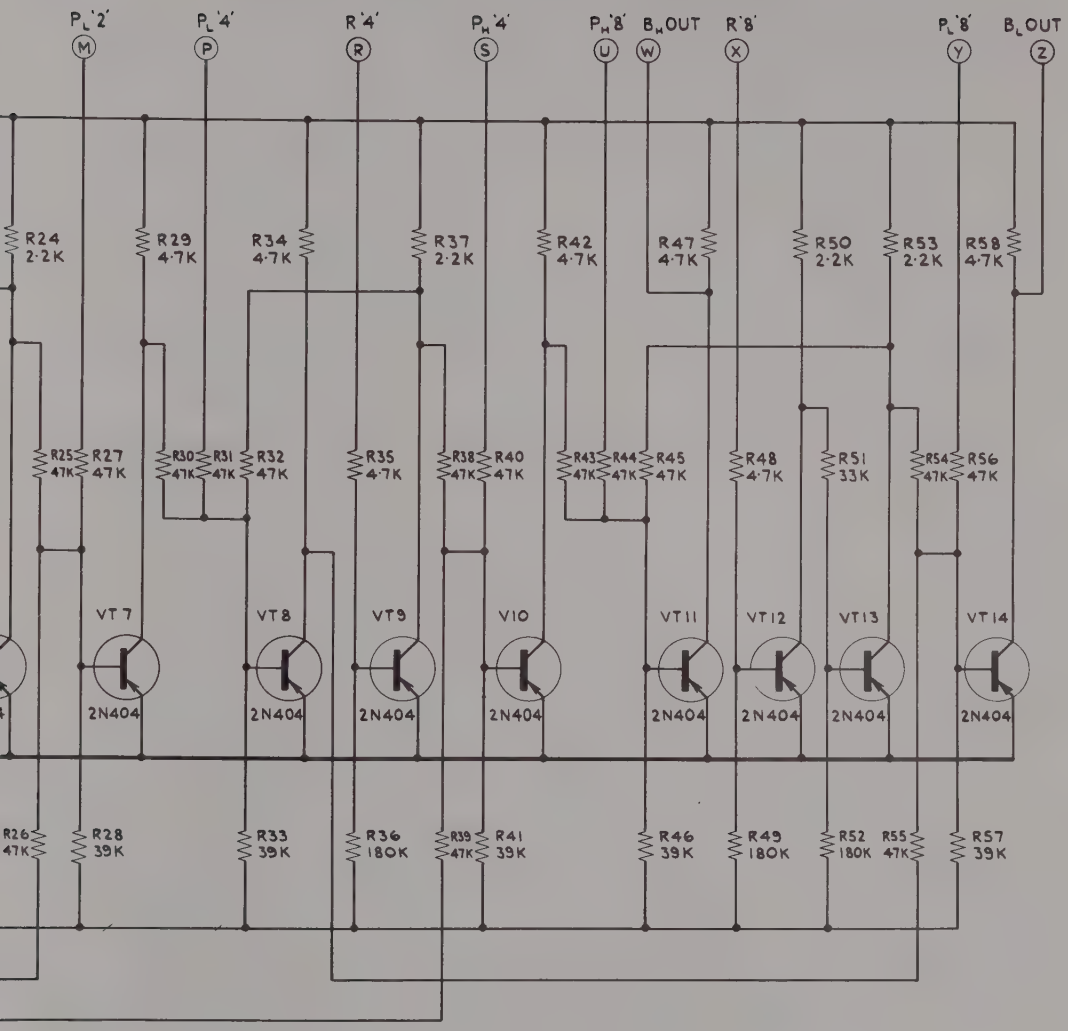
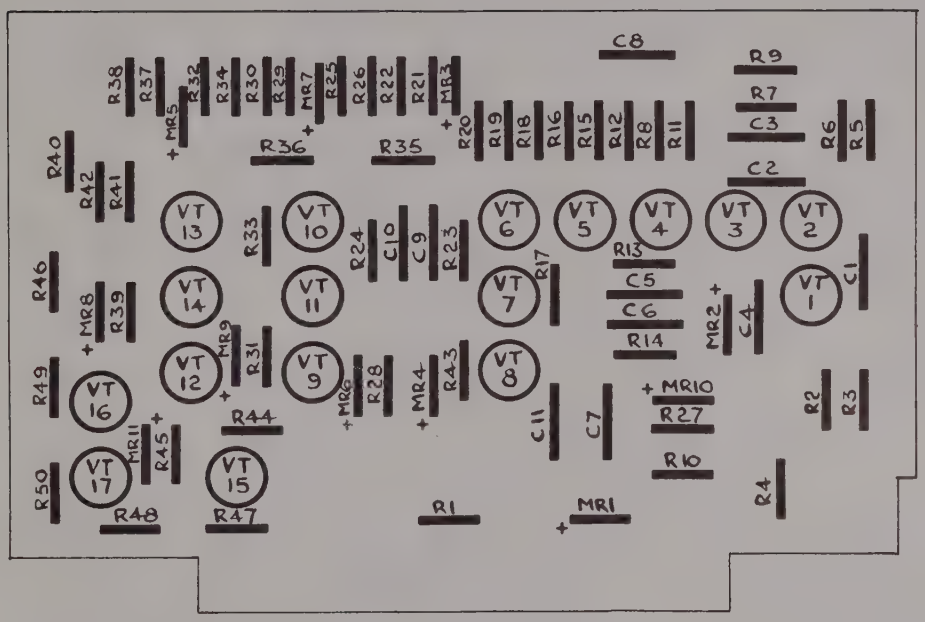
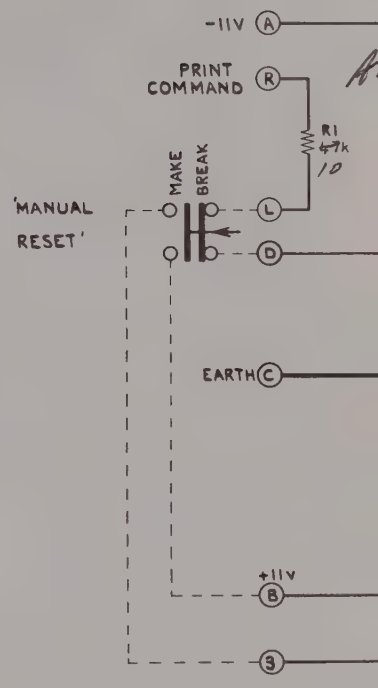
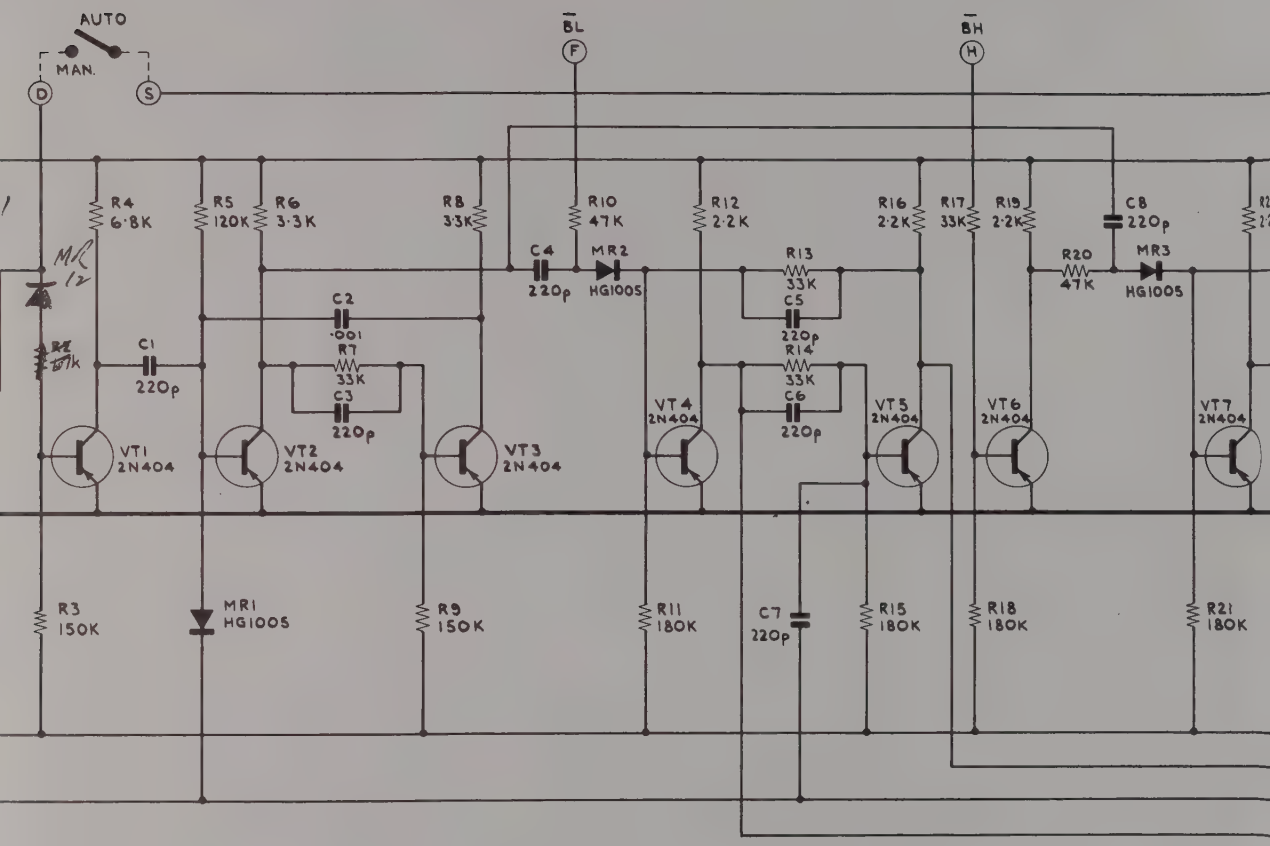


Fig. 4.2 Dual Limit Comparator: TM 7869


C8
R9
R7
C3
R6
R5
C2
C1
C4
C5
C6
R14
R13
R17
R12
R8
R11
R15
R16
R18
R19
R20
MR3
R21
R22
R26
MR7
R29
R30
R34
R32
MR5
R37
R38
R36
R35
R40
R42
R41
R46
MR8
R39
R49
VT 16
MR11
R45
R50
VT 17
R48
R44
MR9
R31
VT 12
VT 14
VT 13
R33
VT 10
VT 11
VT 9
MR6
R28
R24
C10
C9
R23
MR4
R43
VT 6
VT 7
VT 8
VT 5
VT 4
VT 3
VT 2
VT 1
MR2
C11
C7
MR10
R27
R10
R2
R3
R4
R1
MR1
R47
VT 15


-11V
A
PRINT COMMAND
R
R1 47k 10
MAKE
BREAK
'MANUAL RESET'
L
D
EARTH
C
+11V
B
3


AUTO
MAN.
D
S
BL
F
BH
H
R4 6·8K
R5 120K
R6 3·3K
R8 33K
R10 47K
R12 2·2K
R16 2·2K
R17 33K
R19 2·2K
C8 220p
C4 220p
MR2 HG1005
R13 33K
C5 220p
R20 47K
MR3 HG1005
C2 ·001
C1 220p
R7 33K
C3 220p
R14 33K
C6 220p
VT1 2N404
VT2 2N404
VT3 2N404
VT4 2N404
VT5 2N404
VT6 2N404
VT7 2N404
R3 150K
MR1 HG1005
R9 150K
R11 180K
C7 220p
R15 180K
R18 180K
R21 180K

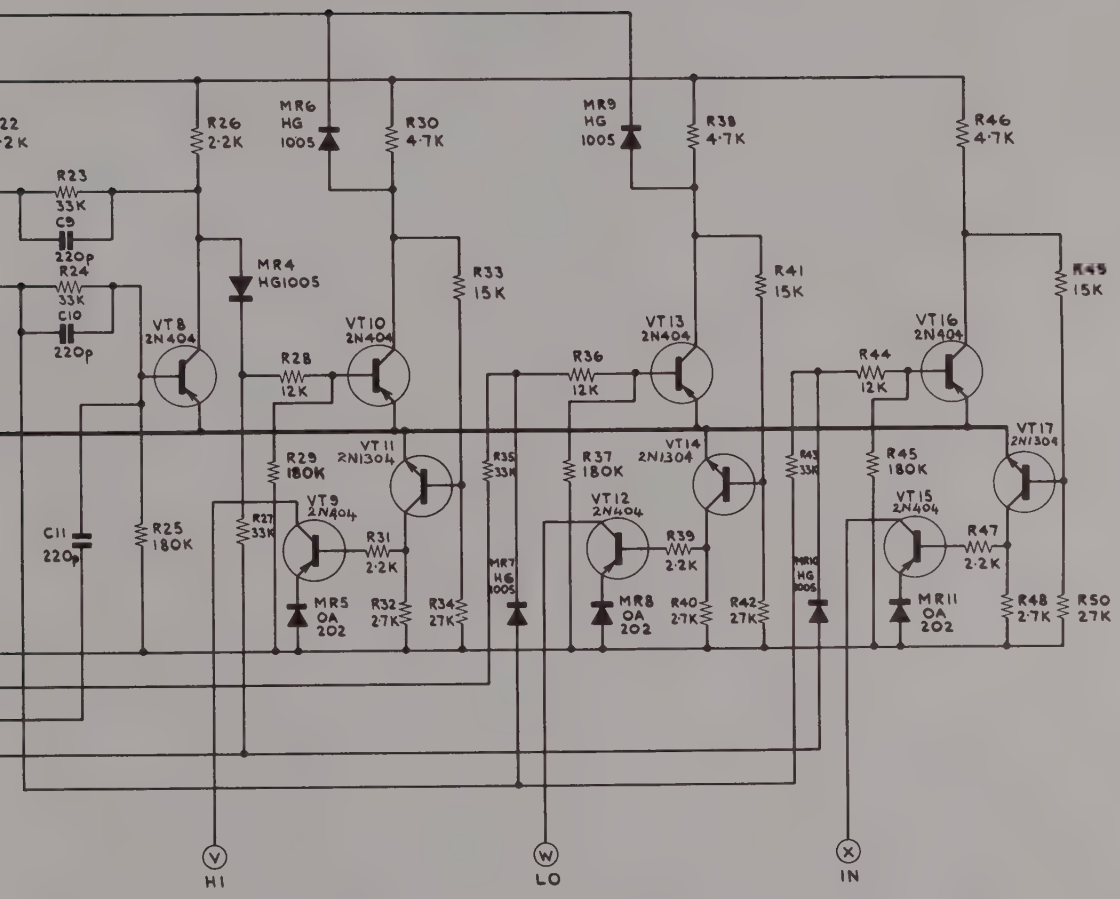
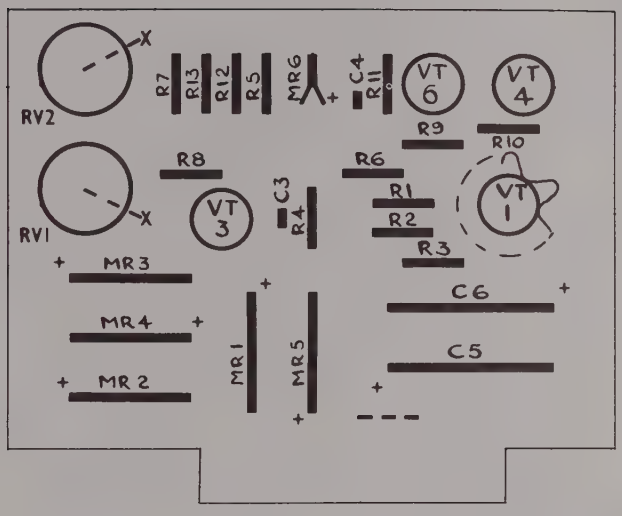


Fig. 4.3 Out of Limits Output Circuit: TM 7872


RV2
X
R7
R13
R12
R5
MR6
C4
R11
VT 6
VT 4
R9
R10
RV1
X
R8
VT 3
C3
R4
R6
R1
R2
R3
VT 1
MR3
MR4
MR2
MR1
MR5
C6
C5

190-260V

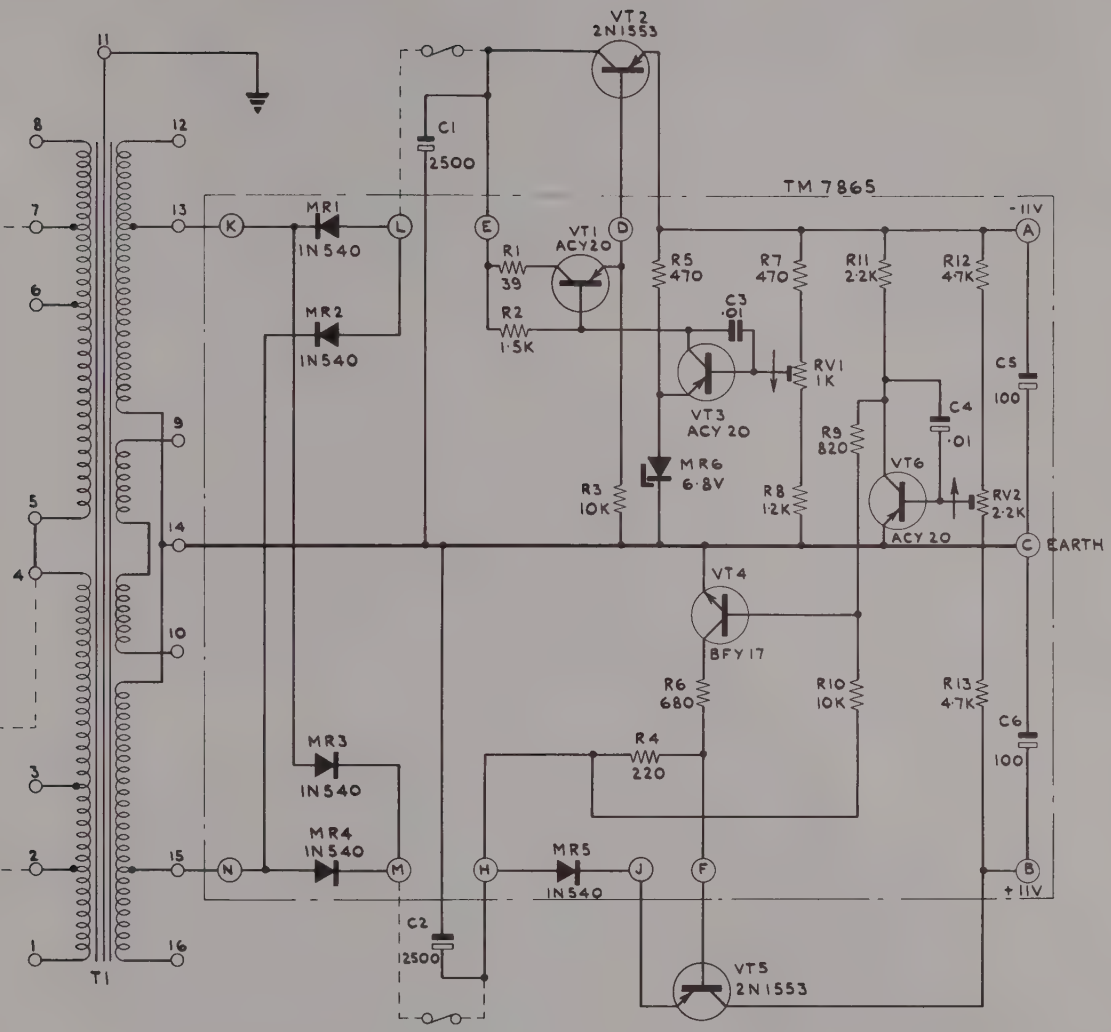
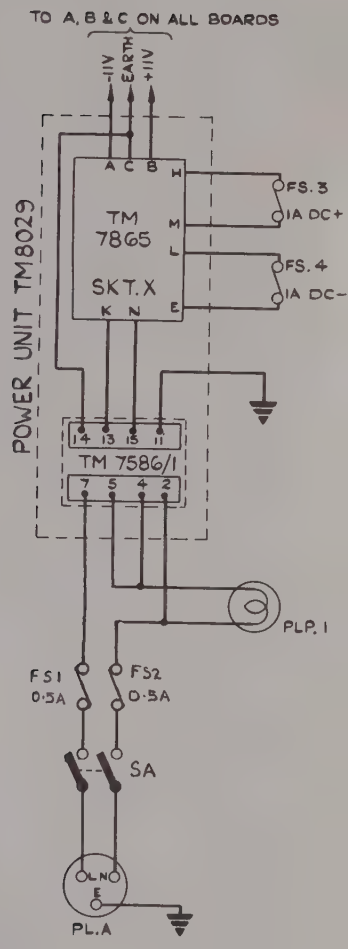
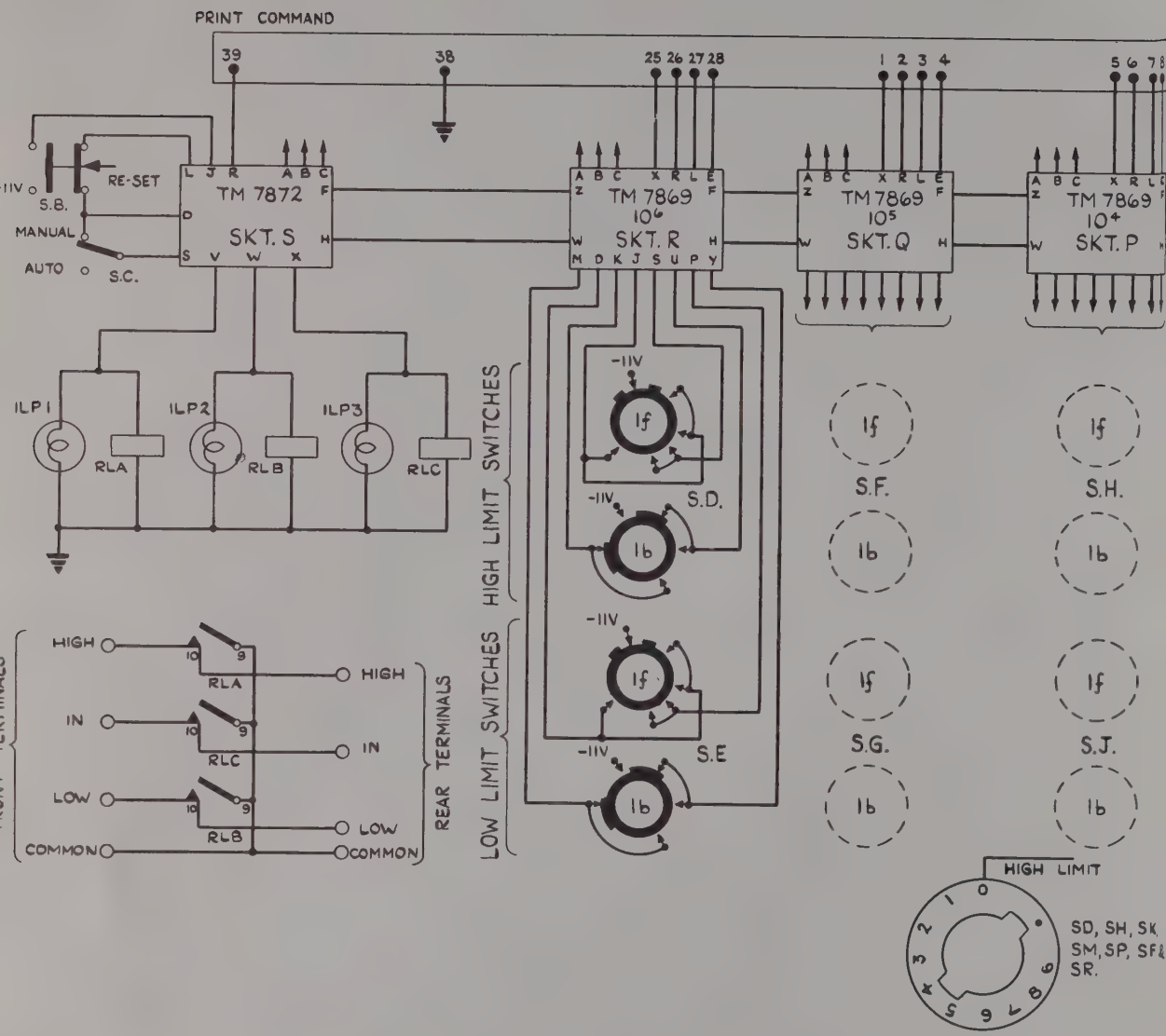


Fig. 4.4 Power Supply: TM 7865


TO A, B & C ON ALL BOARDS
-11V
EARTH
+11V
POWER UNIT TM8029
A C B
TM
7865
SKT. X
K N E
H
M
L
FS. 3
1A DC+
FS. 4
1A DC-
14 13 15 11
TM 7586/1
7 5 4 2
PLP. 1
FS1
0·5A
FS2
0·5A
SA
L N O
E
PL. A


PRINT COMMAND
39
38
25 26 27 28
1 2 3 4
5 6 7 8
-11V
S.B.
RE-SET
MANUAL
AUTO
S.C.
TM 7872
SKT. S
TM 7869
10⁶
SKT. R
TM 7869
10⁵
SKT. Q
TM 7869
10⁴
SKT. P
ILP1
ILP2
ILP3
RLA
RLB
RLC
HIGH LIMIT SWITCHES
LOW LIMIT SWITCHES
-11V
1f
1b
S.D.
S.E
S.F.
S.G.
S.H.
S.J.
HIGH
IN
LOW
COMMON
REAR TERMINALS
HIGH LIMIT
SD, SH, SK
SM, SP, SF
SR.

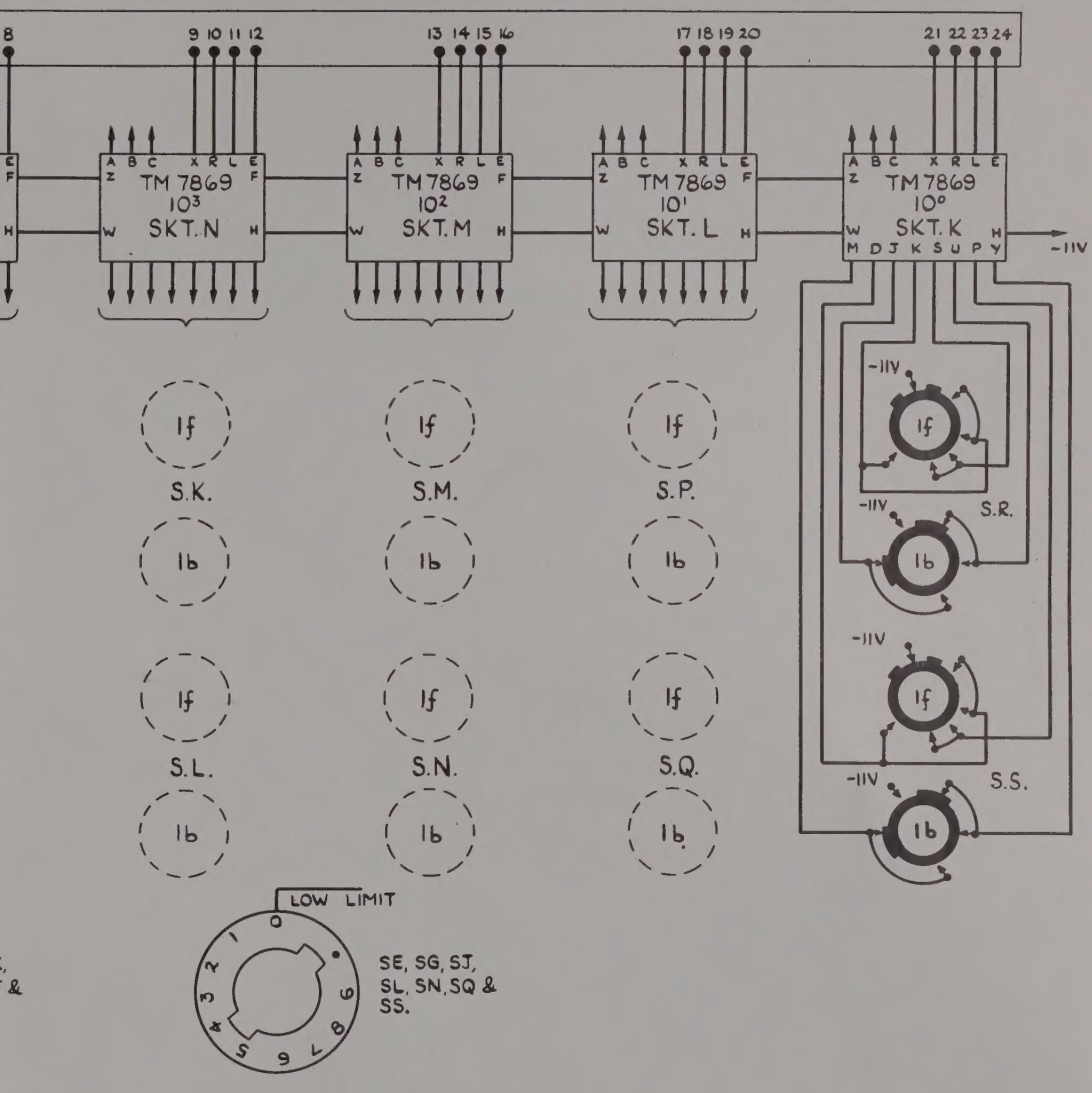


Fig. 4.5 Interconnecting diagram

TF 2404

MARCONI INSTRUMENTS LIMITED
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Printed in England by The Campfield Press, St. Albans